Continuous online D/H measurements of hydrous minerals

Completed Technology Project (2014 - 2015)

Project Introduction

The ratio of the heavy to light hydrogen isotopes (D/H) is used to understand the history of planetary atmospheres and the role of water in the formation of surface materials. For example, D/H measurements of clay minerals on Mars can be used to understand the hydrological setting at the time of formation. This IRAD proposes to develop a system to measure the D/H isotope ratio of hydrous minerals. The ratio of the heavy to light hydrogen isotopes (D/H) is used to understand the history of planetary atmospheres and the role of water in the formation of surface materials. For example, D/H measurements of clay minerals on Mars can be used to understand the hydrological setting at the time of formation. This IRAD proposes to develop a system to measure the D/H isotope ratio of hydrous minerals.

The goal of this project is to develop a system to measure the D/H ratio of hydrous phases of planetary analog samples and martian (SNC) meteorites. To do this, we will couple a state-of-the art Commercial Water Isotope Analyzer (for D/H and $^{18}O/^{16}O$ of water, here after presented in del notation as δD and $\delta^{18}O$) with a custom front end to thermally evolve water from samples under a carrier gas stream. The front end will be capable of stepped heating, in which water evolved at different temperatures is collected and then injected in bulk to the analyzer, and continuous heating, in which the δD of water is analyzed continuously as it is evolved from a sample.

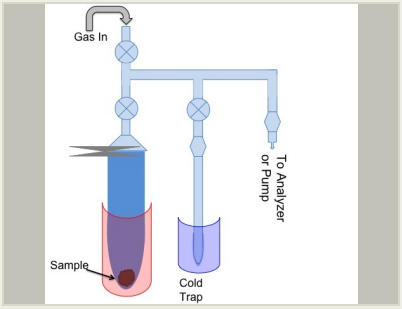
Stepped heating is a conventional method used to study the isotopic composition of volatiles in meteorites because the mass spectrometer must receive discrete pulse of gas, as isotope ratios are measured by integrating the areas under peaks of different masses of interest. Optical isotope analyzers, only recently commercially available, can continuously measure high precision isotope ratios of trace amounts of water, which could enable continuous δD measurement of waters thermally evolved from samples. This may be advantageous over batch methods, especially for samples that have multiple mineral phases releasing waters with different isotopic compositions over a narrow temperature range.

Anticipated Benefits

This innovation will enhance interpretations of data returned from the Sample Analysis at Mars (SAM) instrument suite on the Curiosity Rover. Data obtained will help understand the presence of water on Mars in the past and present, and the history of the martian atmosphere.

This innovation may help any mission in which heating is used to release volatiles from rocks for elemental and isotopic analysis.

This project may benefit geochemists at other federal agencies who are interested in using the D/H and O isotopic composition of water trapped in clays and hydrous minerals to study environmental changes.



Glass Line for water extraction from clays

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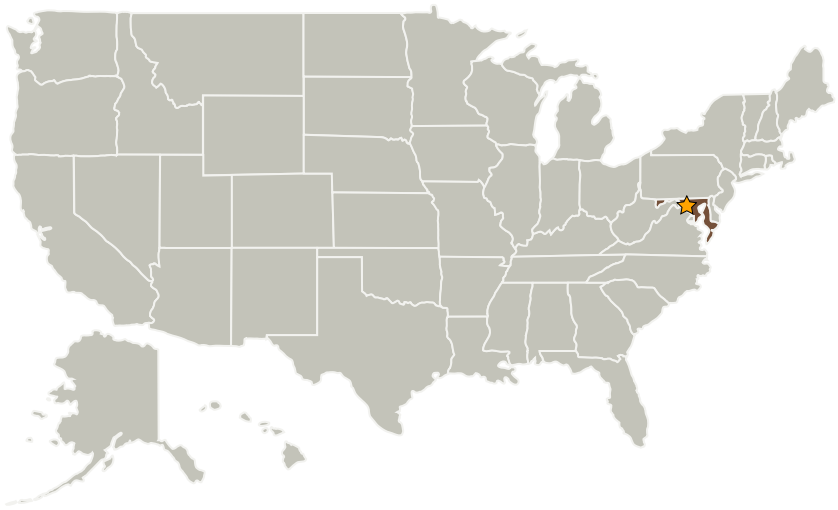
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Brook Lakew

Principal Investigator:

Jennifer C Stern

Co-Investigator:

Amy C Mcadam

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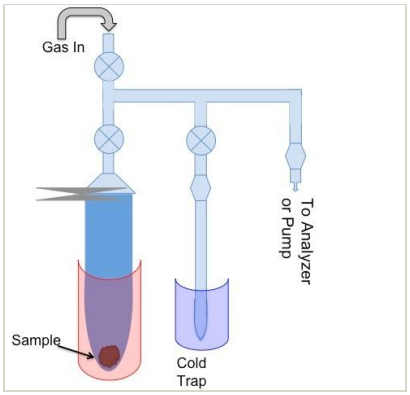
Images



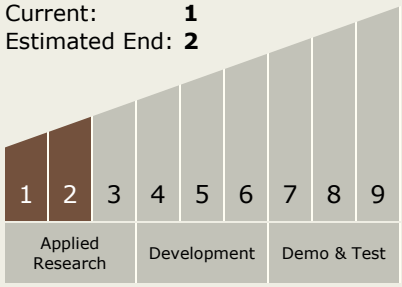
Front end extraction
Glass Line for water extraction from clays
(https://techport.nasa.gov/image/4203)

Project Website:

http://sciences.gsfc.nasa.gov/sed/

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **2**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.2 Atomic and Molecular Species Assessment